TMF

February 1990

THE MAC FLYER - For Greater Safety in MAC Air Operations

1989 MAC Safety Awards Winners . . . page 16

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February 1990 MACSP 127-5 VOL XXXVII NO. 2

page 13

page 24

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Contributions, comments, and criticisms are welcomed. Write: *The MAC Flyer*, HQ MAC/IGFE, Scott AFB, IL 62225-5101. Or call Autovon: 576-3534/5542 or commercial: (618) 256-3534/5542. The editors reserve the right to make editorial changes in manuscripts which they believe will improve the material without altering the author's intended meaning.

Subscriptions are available from: The Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Changes of address for subscription mailing should be sent to the GPO. Give both old and new address, including zip codes. USAF Active and Air Reserve Forces units should establish magazine requirements through the OPR (HQ MAC/IGFE). Other U. S. Military units should consult administrative directives. *The MAC Flyer* is published at an approximate ratio of one magazine for every five MAC crewmembers, and one for every twenty MAC support personnel. Distribution X: OPR: HQ MAC/IGFE ISSN 0024-788X

FEATURES

3 **The Ups and Downs of a C-5 Flight**
Hours of boredom?!

6 **Incapacitation**
Pilot incapacitated? Know what to do!

9 **Swing Low Sweet Chariot**
Landing MAC's wide-body jets.

13 **The Hangover Hazard**
There's only one sure cure.

16 **1989 MAC Safety Awards Winners**

20 **C-141 Structural Design Criteria and Severe Missions**
Keeping within the limits.

24 **C. R. Terror**
Ace of Aerospace strikes up the band.

DEPARTMENTS

18 **Flying-Hour Milestones**
28 **Quickstoppers**
31 **After Deadlines**

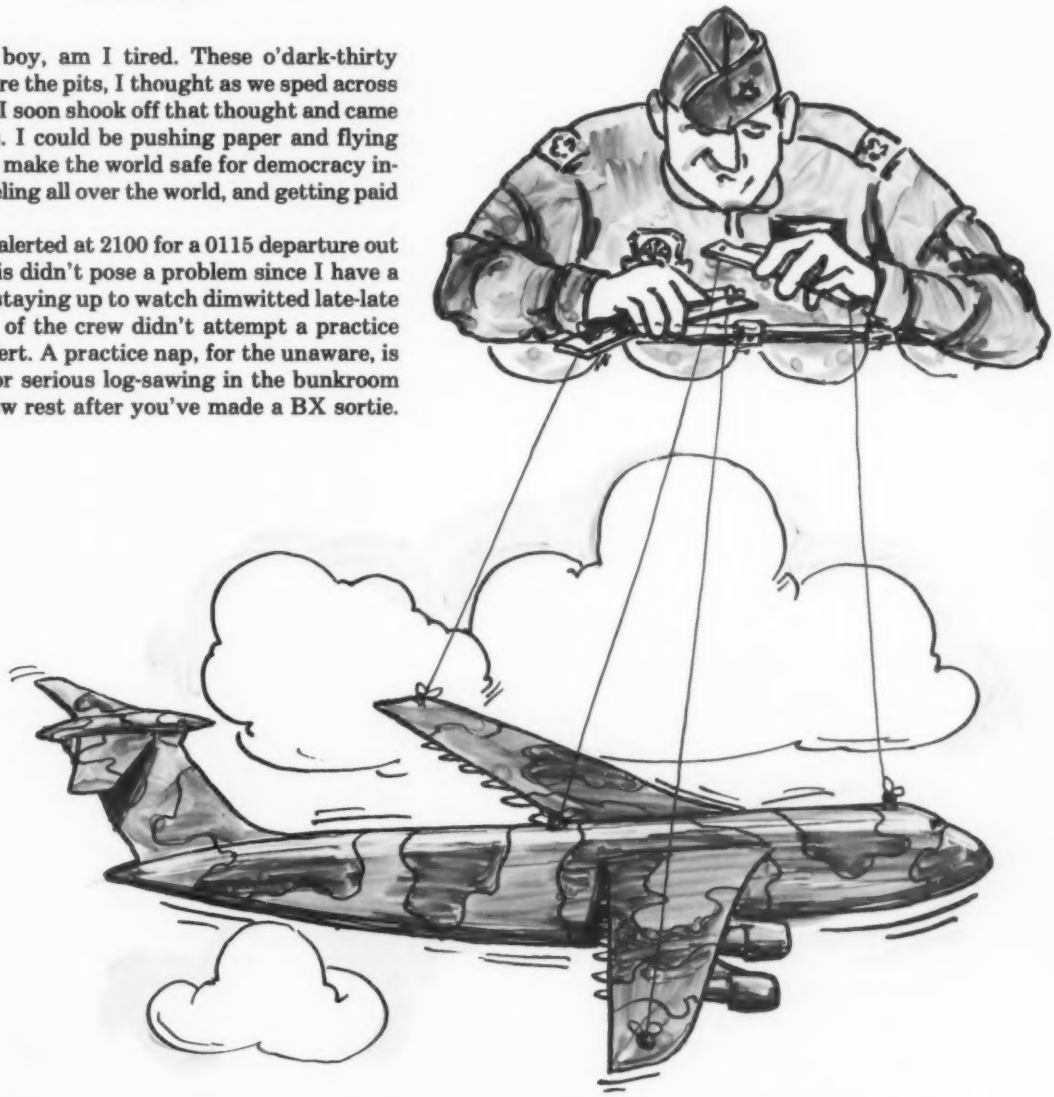
The Ups and Downs of a C-5 Flight

Simulators don't have a monopoly on electrical problems.

By Maj. Terry Mast
Hq MAC/DOTS

Boy, oh boy, am I tired. These o'dark-thirty alerts are the pits, I thought as we sped across the Atlantic. I soon shook off that thought and came to my senses. I could be pushing paper and flying some desk to make the world safe for democracy instead of traveling all over the world, and getting paid for it.

We were alerted at 2100 for a 0115 departure out of Dover. This didn't pose a problem since I have a bad habit of staying up to watch dimwitted late-late shows. Most of the crew didn't attempt a practice nap before alert. A practice nap, for the unaware, is a warm-up for serious log-sawing in the bunkroom or during crew rest after you've made a BX sortie.



1989 MAC FLIGHT SAFETY WRITING CONTEST
HONORABLE MENTION

A practice nap would just play havoc with my circadian rhythm, whatever that is.

Everyone arrived at the squadron early; clarification—two minutes before showtime. We were ready for briefing. For a C-5 crew, the pilot section was a little skosh (two), but the engineer department showed up in force. We had a total of five engineers: a student, an instructor, a scanner, and two flight examiners. The briefing was the typical spiel most of us had heard a thousand times, plus or minus. After a few comments about how good our behavior would be during crew rest, we were headed in different directions.

"Maintain aircraft control, analyze the situation, and take proper corrrective action . . . "

The entire pilot force assembled in base ops and began to flight plan. This exercise took 20 to 25 minutes and off we went to weather. The forecast was for severe clear with isolated thunderstorms going across the pond, and low vis on arrival at Ramstein due to ground fog. What else is new? I knew the weather folks had a canned forecast for Ramstein. "Sgoeat," I announced, the time had arrived to partake of a generous helping of epicurean delight. Half a sub for now and half for later, and we were primed for the crewbus.

The evasive crewbus arrived with a driver muttering something about shift change. As we turned out of base ops toward the flightline, it occurred to me there always seemed to be a remarkable amount of activity out there at midnight. I'm sure this was just the "pilot attitude" sneaking out of me, having a momentary memory lapse, and forgetting what it was like back in my maintenance days. We pulled up to the aircraft and I was sure we had the wrong airplane. This one had so many trucks, maintenance stands, and people around it, I knew it was here for depot maintenance. As we got out of the bus, the engineer, taking a smoke break, gave us a thumbs up. What? Is the man blind? I thought, before speaking to anyone. As it turned out, the maintenance people were just paneling up, the load was here, and airfreight and our loadmasters were finishing loading the last pallet and starting to shut the doors. The passenger buses were standing by with a full load of space available fliers, and the entry steps were in place. This was great. For a home station departure, things seemed to be going better than expected.

You haven't experienced a bag drag until you've done a C-5 bag drag. Sometimes the "Es" do us a favor by getting all the bags on before we arrive, but this time they had their hands full tying up loose ends for an on-time departure. We grabbed a free crew chief and started to bag drag. After loosening up with a few calisthenics, I was ready. Naturally, I got stuck in the middle of the crew entry ladder. It takes several years to develop the technique of avoiding this position. The first few bags were no problem, and I thought I'd finally gotten in shape. Then came the one that said "think again buffalo breath." Whoever this bag belonged to took the 30-day undies requirement seriously! I had no doubt he was PCSing and taking his entire shipment of household goods in this one bag. After another 25 or 30 bags, I was ready to relax and go to work. After climbing the stairs to the upper chambers, commonly referred to as the flight deck, all that was left to do was check the forms, warm up the radios, and build my nest for the long trip. With charts, flight plans, checklists, flashlights, and kneeboard in place, I felt I could be comfortable.

Almost like magic, the crowd started to thin out and forms were signed. Time to light the fires and hit the road. I knew it was time to go since I was getting pretty bushed. Nothing like flying at night to reconfirm your decision to become a pilot. The air is smooth and you always have a window seat. The route up the east coast at this time of night offered plenty of opportunity to use the window. Besides air traffic, the view of Atlantic City and New York City, among others, was great. A couple of hours up the shoreline and it was time to coast out.

After heading out into darkness, the AC decided he should take a break and have some dinner. That left the engineer and myself up front, as everyone else had long since hit the bunkroom or whatever empty space they could find. The cockpit of a C-5 is not normally the most tranquil place, however, flying at night is very serene. It's as if we're hanging there motionless, waiting for the hours to pass until the continent magically appears in the windscreen. We were approaching the halfway point and my seat was becoming very uncomfortable. Even my sense of smell was picking up strange sensations. "Engineer, do you smell anything?" His response dealt mainly with what I had eaten for my predeparture meal. I was pretty certain what I smelled was the same aroma I noticed when my first car caught on fire.

Seconds later my assigned altitude was two or three thousand feet below me, and the lights on my anunicator panel were flashing like the Fourth of

July. Fumes were now profuse; it was time to don the oxygen masks. My first thought was to ask the instructor to reset the simulator. Nothing I had seen before exactly duplicated the situation, but a bombed simulator came close. "Maintain aircraft control, analyze the situation, and take proper corrective action, get on altitude, now," may not be in the book, but that's how I felt. I knew there were other aircraft up here; I just hoped not too near. As I pushed the nose over, I couldn't help but wonder what was going through the passengers' minds. I remember my thoughts and having fun was not one of them. What the heck is happening? Are we safe? Should we turn back and it's a long swim home, were some of my thoughts.

"Oxygen masks on," I finally stated over the interphone, since that was the boldface for the electrical fire checklist. As I attempted to get mine on, which seemed so easy in the simulator, I glanced back and saw the engineer putting his mask on and opening his checklist. Isn't this the only checklist in the C-5 that has never been completed to the end? I wondered, hoping we wouldn't be the first. That would mean we were having some difficulty finding the fire. As well as using my aviator skills, I also seemed to be hoping a lot, like "I hope we don't have to run the ditching procedures." As I headed back to my altitude, another random thought entered my head, "turn 90 degrees climb or descend." I must have answered that question a hundred times to questioning aircraft commanders on quiet trips across the pond. Wait a minute, I think I have the right answer to the wrong question. The question is not radio-out procedures but emergency procedures, just call ATC, you idiot. This felt like it took hours but in reality was only a matter of seconds.

I declared the emergency and told ATC we were returning to our assigned altitude. As I got back on interphone to ask the engineer how the checklist was going, I noticed the other four engineers on board looking all over the flightdeck. "Engineer, how's it going?" I asked—no response. "Engineer, pilot?" No answer. Looking around and pointing to my headset, I yelled in the interphone, as if it made a difference, "Engineer, come up interphone." Then it hit me; we must have lost the emergency bus since I couldn't hear the engineer or the pilot, and they were on that bus. I could hear myself, and was able to talk to ATC. All this great leadership I was providing was only being heard by myself. Crew training paid off and we had all done our jobs. The scanner had taken the fasteners out of the emergency bus panel and found the power relay had melted. This meant we'd lost the emergency bus which powers the pilot's and engineer's interphone and the autopilot pitch control. This explained the pitch up of the aircraft. After pulling a few key circuit breakers, the electrical fumes started to dissipate. Sometime during this situation, the AC got back in his seat and tried to talk to me over his interphone, which was inop. He glanced down at his ADI which had tumbled, and tried to level out a perfectly level aircraft. I gave him a thump on the arm and yelled for him to look outside at the big attitude indicator in the sky. He let go of the controls and we leveled out again.

After some discussion, we decided we would be better off turning back. After an eight and one-half hour Dover to Dover mission, we made it home safe. I'll have to thank those simulator instructors someday for loading me up in the sim. Although I never had this same emergency presented, I felt the training came in handy when I needed it.

Major Mast was commissioned in 1975 after graduating from the University of Illinois. After completing Maintenance Officers School he was assigned to Homestead AFB, Fla. In March 1979 he began UPT at Columbus AFB, Miss. After receiving his wings he was assigned to C-5s at Dover AFB, Del., where he eventually upgraded to instructor pilot. In Feb 1986 he transferred to Altus AFB, Okla., as an academic instructor and command post controller. At Scott since Aug 1988, he is currently the program manager for C-5 aircrew training systems.

Incapacitation

Pilot incapacitation need not be disastrous.

(Editor's Comments: Crew positions mentioned refer to civil airline operations.)

Despite long hours of training on how to recognize and resolve emergencies dealing with loss of some mechanical component, very little attention has been given to recognizing and coping with loss of a human component. Pilot incapacitation happens more frequently and presents a greater hazard than many mechanical failures.

Incapacitation can happen to pilots of any age and during any phase of flight. The International Civil Aviation Organization revealed that during a 7-year period, there were 17 instances of pilot deaths in the cockpit. Of these 17 deaths, 5 led to fatal accidents resulting in 148 fatalities. In four of the fatal mishaps, death occurred during the approach phase of flight. Two-thirds of the 17 pilots who died were under the age of 50.

Examples of total incapacitation are listed below:

—When the First Officer got the approach lights in sight, he informed the Captain, adding that the aircraft was a little left of centerline. The deviation was so slight (approximately 25-50 meters), he was not surprised the Captain did not immediately take corrective action. Some seconds later, with the runway less than one mile distant and the aircraft still left of centerline, he again made a remark to that effect. No immediate correction followed, but after a few seconds, the aircraft turned slightly to the right and the crew assumed this was the expected correction. When, however, the turn continued and the aircraft crossed the centerline, both the Second Officer and Flight Engineer simultaneously called for the First Officer to take over. The First Officer saw the Captain's body incline forward in his shoulder harness, his right hand slipping slowly from the power levers. The height of the aircraft was approximately 150 feet. The First Officer immediately took over full control and carried out a missed-approach.

—The copilot made a particularly good landing from the left seat—so smooth that the other crewmembers commented on it. However, when he put the engines into reverse, the airplane started to drift toward the edge of the runway. The Captain noticed reverse thrust had not been applied symmetrically, and the copilot had slumped over as if still reaching for the throttles. He had no problem taking control of the airplane. The copilot did not regain consciousness.

—The Captain made a very good landing, and applied reverse thrust at about 100 knots. The first indication of anything wrong was when the aircraft started veering to the left; not a great deal, but it would have eventually gone off the runway. At that time, the First Officer looked at the Captain to see if something was wrong. When the pilot slumped forward against the yoke, the First Officer realized he was ill and immediately straightened the aircraft.

In these examples of total incapacitation, the pilot flying the aircraft simply ceased to function. Incapacitation ranged from unconsciousness to death. The second form of pilot incapacitation is subtle, where the pilot flying the aircraft remains conscious, but is partially incapacitated for some mental or emotional reason. This form is perhaps the most dangerous because it occurs with greater frequency and is more difficult to detect.

—A crew on final approach, proceeding to the VOR, was cleared directly to the outer marker. The Captain continued to fly towards the VOR (his RMI switch #2 was tuned to the VOR, and the #1 switch was tuned to the outer marker). The Second Officer noticed the aircraft was not on the right heading. He warned the Captain who responded by telling him to "Shut up." Approach Control vectored them out of the conflicting traffic area for a missed approach after which the Captain recovered and made a normal approach. Cause of subtle loss of function? Preoccupation with personal problems.

—Captain with a particularly good record made a very erratic instrument approach and broke out at 300 feet in heavy rain. Just before reaching the threshold, he felt the aircraft was too high (it was not) and pushed the nose over resulting in a high sink rate. A crash landing resulted with major damage to the aircraft. Cause of poor judgement and performance? Hypoglycemia.

—A two-man crew reached minimums on approach and executed missed approach. On initial climbout the Captain put the aircraft into a very steep climbing turn (approaching stall). The copilot forcibly took the aircraft away and made a normal approach and landing. Cause of abnormal action? Increased sensitivity to vertigo, secondary to brain disease.

As seen from these examples, partial incapacitation may or may not last for an extended period of time. Despite the duration or reason for incapacitation, it is critical that the problem be recognized and resolved.

Coping with human incapacitation involves three phases:

(1) Recognition

(2) Regaining and/or maintaining control of the aircraft and

(3) Solution

"Procedural deviation is the first indication of a problem."

Of these three, the most critical and most difficult is recognition. Every pilot is trained to believe the aircraft commander is the sole authority in the cockpit, that every crewmember knows his/her duties and is totally competent. These are normally valid assumptions designed to allow smooth team effort, coordinated by a single leader. It is, therefore, extremely difficult for one crewmember to challenge the actions of another, particularly if the person challenged is the aircraft commander.

There are warning signals built into the cockpit's mechanical and operational systems. Based on these warning signals and augmented by sound judgement, aircrew members should not only be authorized but obligated to challenge the pilot. These warning systems are based on a "crew concept" of operation in which each crewmember performs his/her own assigned tasks while monitoring the overall operation of the aircraft. *Crewmembers must use standard operating procedures and be alert for any apparent deviations from those procedures without a clear and concise reason.*

The key to the operations warning system is the "two communications" rule. Under this rule, crewmembers should instantly be alerted to possible incapacitation when: (a) the pilot does not respond appropriately to two verbal communications or, (b) the pilot does not respond to any verbal communication associated with a significant deviation from a standard profile.

Crewmembers must be most alert during critical phases of flight, such as takeoff and landing, when stress-oriented failures are most likely to occur. Once a crewmember's suspicions are aroused, he should waste no time ascertaining whether or not the other pilot is incapacitated. Once incapacitation is recognized, the other pilot should immediately take full command of the aircraft, regardless of rank or seniority. While establishing control of the aircraft, the remaining pilot should immediately check the position of essential controls and switches to insure they have not been altered. The Flight Engineer should restrain the incapacitated pilot, slide the seat back, and double-check the position of essential controls and switches. If the stricken pilot is totally incapacitated, he should be removed as soon as possible from the pilot's seat. If unconscious, he should either be removed or restrained to prevent potential problems caused by irrational or uncontrollable reaction upon regaining consciousness.

Once the aircraft is under control and the stricken pilot cared for, cockpit duties should be reorganized to insure safe flight. In many cases, an emergency should be declared and the autopilot used to reduce the workload. Care should be taken to insure concern for the stricken pilot does not interfere with sound judgement and rational decisions. Despite the loss of one crewmember, there is no immediate danger and no emergency situation exists other than that of a stricken pilot.

A study of reactions following loss of a crewmember has shown that pilots demonstrate the ability to perform well in the areas in which they have had prior training. However, the stress of the situation, plus lack of comprehensive training have caused problems. Some representative problems include:

(a) Placing an oxygen mask on the incapacitated pilot but not going to 100 percent merely forces the stricken pilot to breathe ambient air through an uncomfortable mask.

(b) Ordering an emergency evacuation after properly preparing the cockpit for landing with a normal aircraft.

(c) After a good approach and landing, shutting down the engines while still on the runway and requesting an ambulance to remove the stricken pilot. This considerably complicates and delays removal of the pilot.

Questions to be considered when losing a cockpit crewmember in flight include:

What should the remaining crew tell ATC if an incapacitation occurs in the terminal area?

After declaring an emergency, it's helpful to give ATC an estimate of the holding time required and nature of the emergency. Requesting a holding vector rather than a conventional holding pattern can reduce cockpit workload. Do not shortcut the procedure! It is very important to not let concern for the incapacitated pilot rush procedures to the point of jeopardizing aircraft safety.

If the aircraft commander becomes incapacitated, should the copilot change seats? If so, in the air or after landing?

At this stage, the prime concern of the copilot is to make a safe landing. Most airplanes have sufficient directional control from either seat to bring the airplane to a safe stop. After the landing roll has been completed, there may be a case for changing seats, especially if nosewheel steering is only on the left side.

How should cockpit duties be revised and the airplane set up for landing?

This will vary from aircraft to aircraft. It could include such items as putting the airplane in landing configuration earlier than normal. It may be easier for the pilot in control to handle all operational communications. These should be minimal because of the declared emergency.

What about removing the incapacitated pilot from his seat?

It takes two people to remove an unconscious body from an aircraft seat without endangering any controls or switches. If the incapacitated pilot remains in his seat and is given oxygen, the regulator should be at 100 percent and maximum emergency flow.

Should the airplane be taxied to parking or stopped just off the runway?

Once the airplane is safely landed, the prime consideration should be for the incapacitated crewmember. In most cases, this means getting that crewmember to a hospital as soon as possible. The fastest way is to taxi the airplane to where he/she can be expeditiously removed.

How can a pilot insure that he/she does not become a statistic?

If you don't feel well, say so! If on the ground, take yourself off the flight. If in the air, let the other person fly. While there frequently is considerable warning before an incapacitating incident, pilots have not always recognized it. In one of the cited examples, the aircraft commander was not feeling well and even took oxygen on the ground at an en route stop. He flew the final leg himself and became unconscious after getting into reverse at about 100 knots. Cause of death? A sudden heart attack.

Summary

Subtle incapacitations are the most dangerous. They occur most frequently and their effects can range from partial loss of function to complete unconsciousness or death.

The "Two Communications" Rule should be used with judgement. It is a tool which can quickly and efficiently identify situations where a possibility of subtle incapacitation exists.

Routine adherence to standard operating procedures and standard flight profiles (particularly during takeoff and landing) frequently prevent procedural deviations and provide the first indication of a problem. In these cases, the procedural deviation is the first "communication" and any inappropriate verbal response associated with it should be enough to trigger the "index of suspicion."

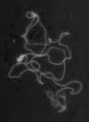
Once an incapacitation is known to exist, follow these positive steps:

(1) Maintain control of the aircraft.

(2) When cockpit matters are under control, take care of the incapacitated crewmember.

(3) Prepare for landing.

Adapted from *Flight Ops*/10, 1989



Swing Low Sweet Chariot

Adjusting your aim point to cross the threshold safely.

America's largest flying machine descended through the night sky inbound to another MAC overseas destination. The new C-5 aircraft commander peered through the thick plexiglas windshield as the wet runway appeared through the parting rain clouds.

"In sight," he said to no one in particular.

Everything felt good. The visual glide path looked normal. He eased the throttles off and noted the distant rumble as the gear lowered onto the asphalt.

After shutdown, the bad news arrived.

"Sir, we hit the overrun on landing." The major sat back in the seat. How could it have happened? He'd done approaches like that hundreds of times in his "old" airplane, the C-141.

By Maj. Donald R. Dillman
Mississippi Air National Guard

MAC is moving more and more into the world of "wide-body" jets; more C-5s, C-17s just around the corner, and the new Air Force One, the VC-25A (747-200). Because of their huge size, all these airplanes bring tremendous advances to airlift, however, they also bring their own unique problems. Many of these problems show up on landing. Checking out in a wide-body jet, you quickly figure out there's a lot of airplane beneath and behind you. Even for a pilot familiar with old reliable, the "heavy" C-141, there's a big change.

Aircraft	Pilot Eye Height at Threshold	Gear Height at Threshold	Touchdown Distance	
C-141	50	39	744	(Flaps 100%)
C-5	50	14	267	(Flaps 100%)
VC-25A	50	18	344	(Flaps 30)
KC-10	50	12	229	(Flaps 35)

Fig. 1. Visual Approach (3-degree glide slope, no flare, distances in feet)

For instance, a C-141 pilot sits approximately 13 feet in the air and 68 feet in front of the main gear. The C-5 pilot, on the other hand, sits over 27 feet in the air and just over 100 feet from the mains. In the air, the differences become more dramatic. A C-141 on a 3-degree final flies at about a -2.5 degree body angle. The C-5 has a body angle of just over 4 degrees. Because of the increased fuselage pitch angle, the gear is pushed even lower beneath the pilot.

Visual Approach

D. P. Davies sums up jumbo jet operating problems in the excellent book, HANDLING THE BIG JETS. "Due to the size of the airplane and its high pilot eye level, there are initially two potential difficulties; first is that it's easy to get too low close in and second is that judgement of flare height and of height above the runway generally is not easy." Conventional airplanes normally use a 1,000-foot runway aim point and a 3-degree glide path. VASI glide slopes and runway markings, both precision and non-precision, all lead to the 1,000-foot point. A VASI glide path will put the pilot's eyes over the threshold at 50 feet. Unfortunately, this is not high enough in the very large airplane.

Common sense and regulations both tell us the crossing heights shown in Fig. 1 are inadequate. Increasing them to 50 feet brings about seemingly extreme eye heights at the threshold. A 50-foot main gear threshold crossing height (TCH) in the VC-25A produces an astonishing pilot eye height of 89 feet, but results in a touchdown point of approximately 950 with no flare (add approximately 500 feet for the flare).

Using the 1,000-foot aim point to touchdown is unacceptable in a very large airplane. There are, however, numerous techniques in use for aim point and visual approach execution. Here are two of the most common. The first technique uses a 1,000-foot aim point and shifts further down the runway at some low altitude, anywhere from 100 to 500 feet AGL. The advantages of this technique are the inital use of the two bar VASI and the "normal" 1,000-foot aim point. The disadvantage is, it produces an unstable final. When you should be fine tuning the sink rate and power settings, everything is changed for the new aim point and glide path. The technique gives adequate clearance if started by at least 300 feet, but may result in a long landing since it produces a shallower glide path than the normal 3 degrees. Using the C-5, here is how the technique works:

The above figure does not include flare. There may be cases where little or no flare occurs; such as during a minimum run landing or because of a late flare due to low pilot experience, or during periods of limited visibility. However, according to the Boeing Flight Training Manual for the 747-200, "A normal flare initiated at approximately 30 feet above the touchdown elevation will increase the (illustrated) gear touchdown points by about 500 feet." This is typical of most jumbo aircraft. The recommended technique is to

Altitude of Aim Point Shift	New Aim Point	Touchdown (feet)	Main Gear Threshold Crossing Height	New Aim Point	Touchdown (feet)	Main Gear Threshold Crossing Height
500 ft	1500 ft	775	39 ft	2000 ft	1229	58
300 ft	1500 ft	740	36 ft	2000 ft	1174	53
100 ft	1500 ft	605	25 ft	2000 ft	895	31

Fig. 2. Shifting Aim Point, Visual Approach (C-5, initial 1,000 - foot aim point, 3-degree glide slope, no flare)

Aircraft	Aim Point	Pilot Eye Height at Threshold	Main Gear Height at Threshold	Touchdown Point
C-5	1,500	79	42	801
VC-25A	1,500	79	40	463
KC-10	1,500	79	41	782
C-5	1,800	94	57	1,106
VC-25A	1,800	94	55	1,049
KC-10	1,800	94	56	1,068

Fig. 3. 1,500/1,800-foot Aim Point—Visual Approach (3-degree glide slope, no flare, distances in feet)

change the pitch a degree or two and wait for touchdown (rather than hold the aircraft off). However, according to D. P. Davies, "Because one is so far away from the ground and the gear, it is unreasonable to pretend that the airplane can be landed with any real precision, measured in small values of feet of height or distance, knots of airspeed, or seconds of time. One simply sets up a projected flight path and waits for the airplane to achieve it."

When wide-body jets were introduced into the civilian environment, the FAA, manufacturers, and operators quickly realized the two-bar VASI was unsuitable for their use, so the three-bar VASI was introduced. According to the Airman's Information Manual (AIM), "Three-bar VASI installations provide two visual glide paths. The lower glide path is provided by the near and middle bars and is normally set at 3 degrees, while the upper glide path, provided by the middle and far bars, is normally 1/4 degree higher." The aim point provided by the three-bar system is near the 1,500 foot point. The design of the three-bar VASI leads to a very common technique: a constant glide slope based on an aim point other than 1,000 feet.

The Boeing Flight Training Manual for the B-747 recommends a 2,000-foot aim point. The American Airlines DC-10 operating manual, from which the KC-10 initial training program was developed, states: "The 'aim at a thousand-foot point' rule will not work in the DC-10 . . . a visual aim point approximately 1,800 feet beyond the threshold is recommended." The advantage of the constant aim point is that it stabilizes the approach much further out on final. During a day visual approach, the point can be picked out on the runway relative to the runway markings. On a precision runway, the markings just after the "Captain's bars" begin at 1,500 feet. On a non-precision runway, a fixed distance marker should be at the 1,000-foot point and 1,500 feet can be estimated. At night, the two bar VASI can be used; the upwind (far) light bar is approximately 1,200-1,300 feet from the threshold and can be used as an aim point. Again, the visual aim point is not where the airplane will touch down, but is the point required to provide a stabilized glide path and adequate gear clearance for a very large airplane.

Using the three-bar VASI provides all the safety features of the normal VASI plus the added threshold crossing height. It also develops the habit patterns of using the aim points required by the very large aircraft. At the present time, only one runway possesses a three-bar VASI where Active, Reserve, or Guard C-5s are based (Runway 9/27 Stewart Intl); and none are located where the VC-25A or KC-10's are based.

One final technique. Radar altimeter callouts are a tremendous aid in a wide-body on short final and beginning the flare. They are especially important during low visibility and night approaches when visual landing cues are in short supply. Here are some common altitude callouts and corresponding visual reference:

100 feet - overrun going under nose

50 feet - threshold just disappeared under nose

20 feet - landing/flare attitude

ILS Approach

The same landing gear TCH considerations exist during an ILS approach, however, the concern then becomes the crossing height of the glide slope antenna instead of the pilot's eyes. TERPs points out that 50 feet is the desired TCH of the ILS glide slope (with a maximum of 60 feet and minimum of

Aircraft	GS Antenna Height at Threshold	Main Gear Height at Threshold	Pilot Eye Height at Threshold
C-141	50	47	58
C-5	50	28	63
VC-25A	50	30	71
KC-10	50	21	59

Fig. 4. Threshold Crossing Height—ILS Approach (3-degree glide slope, no flare, distances in feet)

32 feet). The C-141 glide slope antenna sits only 4.5 feet above the ground. On final there is a three-foot vertical difference between the antenna and the main landing gear (the difference is caused by strut extension and a negative body angle). The C-5 antenna is located on the forward pressure bulkhead, almost as high as a C-141 pilot—12 feet. Airborne, this distance grows to 22.5 feet because of strut extension and body angle. (The 747's antenna is on the nose gear doors and the KC-10's is on the underside of the fuselage, near the radome.)

A precision final in the C-5 doubles the threshold crossing height when "on glide slope." Again from D. P. Davies, speaking about the 747, "These numbers are theoretical minima because, on a flight director approach, the glide slope is abandoned, certainly by 100 feet minimum, and the pilot enters the pre-flare thinking phase. He starts the flare, it is suggested, at a wheel height of 50 feet, so the actual threshold wheel clearances are greater. What is comforting to know is that an accurate ILS approach, whether manual, flight director, or automatic, will result in adequate wheel clearances at the threshold."

Sitting Height

Pilot sitting height is critical in a very large airplane. The three military jumbos have the following design downward visibility limits: C-5, 17 degrees; VC-25A, 18.5 degrees; and KC-10, 20 degrees. While each airplane may have specific seat adjustment guidelines, in general, if you can look down the glareshield and see the lowest point where the glareshield and windshield meet you are sitting high enough.

Sitting low in a very big airplane has the same effect as in any other airplane: it usually causes a lower than desired approach. The already discussed problems of threshold crossing height are more pronounced if the pilot is sitting lower than normal.

Seat position also has a big effect on the visual cues available during the approach and landing phase. For example, on a C-5, Category II, ILS (1200 RVR, 100 DH), approximately 600 feet of ground can normally be seen. The aircraft is approaching with a 4.2-degree pitch attitude on a 3-degree glide slope, resulting in a 12.8 degree downward vision angle. A pilot sitting only one inch low, sacrifices 200 feet of visibility. Sitting two inches low will make it *unlikely the pilot will see the ground at DH during a CAT II approach!*

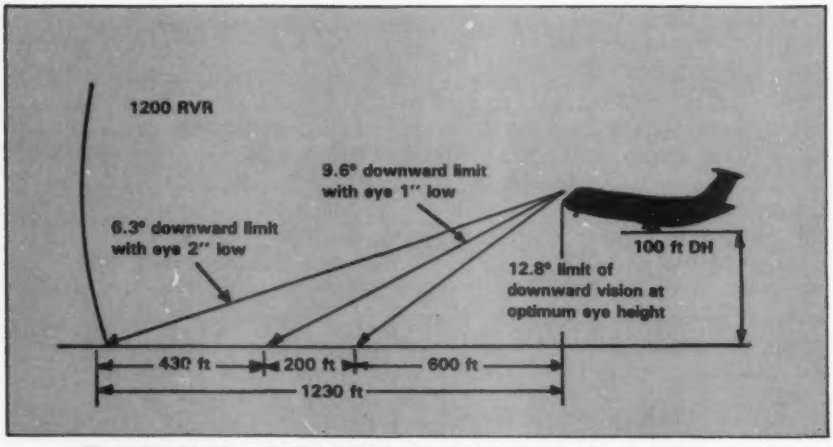

1200 RVR
9.6° downward limit with eye 1" low
6.3° downward limit with eye 2" low
100 ft DH
12.8° limit of downward vision at optimum eye height
430 ft
200 ft
600 ft
1230 ft

Fig. 5. Seat Position—CAT II ILS (3-degree glide slope, DH 100, 1200 RVR)

What It All Means

Use of the 1,000-foot aim point to touchdown will not work in a wide-body aircraft.

At 50-feet radio altitude, the threshold should just be passing under the nose. If you can still see the threshold, you are too low.

An accurate ILS will always result in adequate wheel clearance if TCH is met.

Don't use the two-bar VASI for guidance below 300 feet.

Radar altimeter altitude callouts should always be used, especially during night and low visibility approaches.

Low seat height drastically reduces, or eliminates, the ability to fly a low visibility approach.

The Hangover Hazard

It takes longer than you think!

The immediate effects of alcohol on an individual's performance are generally well appreciated and reflected in the widespread social condemnation of drinking and driving. Perhaps less well understood are the residual effects of alcohol consumption. Degradation of performance can still occur well after the short-term influence has dissipated.

ALCOHOL CONSUMPTION

The alcohol in beer, wine, and mixed drinks is ethyl alcohol, a central nervous system depressant. From a medical point of view, it acts upon your body much like a general anaesthetic. The "dose," of course, is much lower, and is more slowly absorbed, but the basic effects on your central nervous system are similar.

You have undoubtedly heard alcohol is a depressant, not a stimulant. Yet, after one or two drinks, you certainly feel stimulated. This sensation is misleading and occurs because part of the depressant action of alcohol, working on the brain, brings about a release from psychosocial restraints and inhibitions. You may enjoy a feeling of security, well-being, confidence, and freedom from pressure. In reality, however, your thinking becomes sluggish, you respond to urgent situations less efficiently, and your ability to perform simple tasks with speed and accuracy is diminished. If you happen to be tired, hungry, or under stress, these handicaps will be compounded.

The effect of alcohol is greatly multiplied when a person is exposed to altitude. Two drinks at sea

level are equivalent to three or four in the air. The reason for this is alcohol interferes with the ability of the brain to use oxygen. The effects are rapid, first because alcohol passes so quickly into the bloodstream, and secondly because the brain is a highly vascular organ, immediately sensitive to changes in the blood. For a crewmember, lower oxygen availability at altitude, along with lower capability of the brain (under the influence of alcohol) to use what oxygen there is, makes a deadly combination.

HOW LONG IS PERFORMANCE AFFECTED?

The approach to alcohol and flying generally seems very mature, and there are few recorded examples of people trying to operate an aircraft while suffering from the immediate effects of alcohol. However, what many crewmembers may not appreciate is the noxious consequences of drinking can adversely affect performance for up to 48 hours. This was clearly illustrated in a series of experiments.

Tests were conducted on volunteers, in a flight simulator using a blood level of 0.08 percent (which is considered to be a safe level by some). Almost without exception, the subjects committed very serious errors. These errors, had the aircraft been real, frequently would have resulted in fatal mishaps. At the least, they would have placed the plane and its occupants in potentially dangerous attitudes and situations. The most interesting finding overall was that the effects of the alcohol were greatest on those pilots who, on non-alcohol flights, had shown themselves to be the smoothest, best coordinated, most flawless, and coolest under pressure. If they were relaxed when they entered the flight simulator, this condition was drastically changed by the alcohol and performance deteriorated accordingly.

Behavior such as dumping fuel, putting the landing gear down at high speeds, placing the aircraft in unrecoverable attitudes, and attempting to land at 10,780 feet rather than 780 feet (the local field elevation), were but a few examples. So that these findings could not be attributed to chance, the experiments were repeated using different subjects, with basically the same results.

A follow-on study examined the effects of alcohol on errors of omission, that is, forgetting an important function or overlooking an important detail. For this study, emphasis was placed on how accurately subjects could follow a preflight checklist. The subjects accomplished a 78-item checklist on every flight. The task in this experiment was basically the same as for any pilot: begin with the first item and, sequentially, perform each function listed continuing systematically until all items had been completed.

Prior to flight, the experimenters, without the knowledge of the subjects, preset several errors:

- Brakes OFF
- Landing gear handle UP
- Altimeter error of 1,000 feet.

Close adherence to the checklist should have caught all the preset errors. Each subject "flew" two test flights; one without alcohol and, about one month later, one with a 0.08 percent blood alcohol level. Results were as follows:

Under no-alcohol conditions, 11 percent of all subjects failed to correct at least one major preset error.

Under the influence of alcohol, 79 percent of all subjects failed to correct at least one major error. These pilots were legally sober and capable of driving an automobile in most states.

The majority of experiments were conducted in late afternoon or early evening. Experimenters noticed that some subjects complained the following morning they still "felt lousy" due to the previous day's flight. A check of literature showed the amounts of alcohol ingested should have been metabolized within 10 hours after drinking. In addition, from a review of airline publications and military aviation journals, it was also noted the general rule of thumb for drinking was to allow 8 to 12 hours between "bottle and throttle." It was suspected that, although there was no longer any detectable alcohol in the blood, hangover effects might still produce a decrease in performance. Another experiment tested subjects to determine the so-called "hangover" or residual effects of alcohol.

The subjects were already familiar with the basics of flying as well as preflight, in-flight, and postflight checklist responses, prior to the experiment. A 6-inch by 9-inch card containing a detailed checklist was given to each subject, and all were told to adhere to it religiously. This was followed by an actual "hands on" simulated flight consisting of takeoff, climb-out, leveling at altitude, and full-stop landing. When the subjects reached the point where they could successfully handle their fully checklisted "flights" at least three times consecutively without the slightest error, the experiment was begun.

After this pre-training but before the first test flight (nonalcoholic), the following errors were preset by the experimenters:

- Brakes were placed in the OFF position
- Landing gear handle was put in the UP position
- Fuel select switch was placed on auxiliary tanks
- Wing flaps were set at 50 percent
- Altimeter was adjusted to 1,000 feet above local ground level.

At the preflight briefing, each subject was told to take off, climb to 6,000 feet, and maintain for 5 minutes. When requested to do so, the subject was to prepare for and complete the landing at his discretion. The statistics obtained from non-alcoholic flights recorded the number of preset errors each subject failed to correct prior to takeoff.

The only essential difference between the flights described above and the second test flight (alcohol) was that, 30 minutes before takeoff each subject was given enough 80 percent vodka to attain a blood alcohol level of 0.10 percent.

Finally, a third test flight was given 14 hours after the alcohol flight.

The results were interesting, to say the least. During the first test flight (non-alcoholic), 10 percent of all subjects overlooked at least one of the major preset errors. For the alcohol flight, 89 percent of all subjects made at least one oversight error. Fourteen hours after alcohol intake, 68 percent of all subjects still overlooked at least one preset error! It became apparent that performance 14 hours after drinking was much more like that demonstrated 30 minutes after intake, than that of the first non-alcohol flight.

WHAT ARE THE CAUSES OF THE RESIDUAL EFFECTS?

One effect of alcohol consumption is a temporary alteration of fluid balance. Drinking alcoholic beverages dehydrates your body by stimulating the kidneys to produce an abnormal volume of diluted urine so the body loses more fluid than it takes in. This dehydration produces a concentration of all the solutes normally found in body fluids, and this alcohol-induced chemical concentration causes weakness, fatigue, and irritability.

Another element in the making of a hangover is the assortment of organic impurities found in alcoholic beverages. These aldehydes, ketones, and other substances are metabolized in complex ways and may remain in the bloodstream long after the alcohol itself is gone. As long as these substances are present, they produce unfavorable side effects.

CONCLUSION

The prevention of the short-term and long-term (hangover) effects of alcohol is simple—don't drink.

The cure for a hangover is also simple— wait; and before taking to the air you may need to wait 48 hours.

Adapted from *Flight Safety Bulletin.*

1989 MAC Safety

MAC Flight Safety Achievement Award

(Colocated units share in the award.)

Category I

39 SOW
62 MAW & 446 MAW(ASSOC)
89 MAW
317 TAW
374 TAW
375 AAW & 932 AAG(ASSOC)
435 TAW
436 MAW & 512 MAW(ASSOC)
437 MAW & 315 MAW(ASSOC)
438 MAW & 514 MAW(ASSOC)
443 MAW
1550 CCTW

Category II

1 SOS
7 SOS
8 SOS
9 SOS
13 MAS
16 SOS
21 SOS
31 SOS
37 ARS
53 WRS
55 SOS
55 WRS
58 MAS
67 SOS
71 ARS
316 TAG
616 MAG
1400 MAS
1402 MAS

Category III

Det 1, 1400 MAS
Det 2, 1400 MAS
Det 5, 1400 MAS
Det 1, 1401 MAS
Det 2, 1401 MAS
Det 3, 1401 MAS
Det 4, 1401 MAS
Det 1, 1402 MAS
Det 3, 1402 MAS
Det 4, 1402 MAS

MAC Distinguished Flying Unit Safety Award

Category I	Category II	Category III
435 TAW	16 SOS	Det 1, 1400 MAS

MAC Trophy For Flight Safety

21 AF

MAC Ground Safety Achievement Award

(Colocated units share in the award.)

Category I

1 SOW
39 SOW
374 TAW
436 MAW
443 MAW
463 TAW

Category II

7 SOS
11 AAS
37 ARS
38 ARS
41 ARS
53 WRS
57 AES
62 APS
71 ARS
316 TAG
375 COMPTSQ
375 SPS
375 SUPS
1375 FTS
1400 MAS
1401 MAS
1467 FCS

Category III

Det 1, 17 WS
Det 5, 37 ARS
Det 3, 625 MASG
Det 5, 625 MASG
Det 7, 1361 AVS
Det 1, 1400 MAS
Det 2, 1400 MAS
Det 2, 1401 MAS
Det 3, 1401 MAS
Det 4, 1401 MAS
Det 1, 1402 MAS

Awards Winners

The Lamar F. Renfro Award for Ground Safety

Category I	Category II	Category III
463 TAW	316 TAG	Det 5, 37 ARS

The Commander in Chief's Trophy for Ground Safety

22 AF

MAC Services/Airlift Divisions Ground Safety Trophy

ARS
AWS

322 ALD
834 ALD

MAC Support Safety Achievement Award

2 MAPS 7 MAPS 603 MASG 611 MASG 628 MASS

MAC Explosives Safety Award

1 SOW 62 MAW 608 APS

MAC Safety Officer of the Year Awards

Primary Duty

Lt. Col. John B. Liegl
443 MAW

Additional Duty

Capt. Craig A. Berlette
316 OMS

MAC Safety NCO of the Year Awards

Primary Duty

TSgt. Glenwood Peterson
316 TAG

Additional Duty

SSgt. Terry J. Tinter
Det 11, 31 WS

(Designations and locations current during awards cycle.)

Flying-Hour Milestones

10,000

185 TAS
Lt. Col. Jean P. Blackard

7,500

53 MAS
SMSgt. Alven M. Sato

57 MAS
MSgt. Bruce A. Hembree
MSgt. Larry S. Allison

86 MAS
MSgt. Myron R. Hysell
TSgt. Terry L. Fox

374 TAW
CMSgt. Arthur West

349 MAW
Lt. Col. David R. Frohman
Maj. Scott E. Wilson, III.
MSgt. Horrace J. Stewart

403 TAW
Brig. Gen. Joe L. Campbell
MSgt. Lee A. Snyder
TSgt. John A. Lestelle

440 TAW
MSgt. Joseph L. Gervasio

446 MAW
Lt. Col. Edward M. Duchnowski
SMSgt. Rusby S. Sides
SMSgt. Robert E. Owen
MSgt. Norman C. Forney
MSgt. Michael T. Golden
MSgt. Bernard D. Keuhn
MSgt. Jarvis L. Owens
MSgt. David K. Trueblood

772 TAS
Lt. Col. Steven M. Nutter
SSgt. Quentin G. Anderson

919 SOG
MSgt. Donald C. Mazerat

943 TAG
MSgt. Donald D. Beisel

5,000

1 MAS
Lt. Col. Thomas Butler
Lt. Col. James W. Chappelear, Jr.
Lt. Col. Gary L. Doyle
Lt. Col. Alexander Escarzaga
Lt. Col. John F. Fenn
Lt. Col. Danny R. Hutton
Lt. Col. Lawrence N. Lacey
Lt. Col. John W. Parrish, Jr.
Lt. Col. Terry D. Rohr
Lt. Col. Wayne A. Sharkey
Lt. Col. Thomas J. Thelen
Maj. Howard Campbell
Maj. Kenneth D. Moore
Maj. Darwin P. Prewitt
Maj. Stephen M. Strack
Maj. Wayne E. Williams
Maj. Coy E. Whitman, Jr.
SMSgt. Albert R. Kauses
SMSgt. George M. Leyendecker
MSgt. Russell L. Brooks
MSgt. Mark L. Buchner
MSgt. Thomas J. Collinson
MSgt. Glenn R. Hirt
MSgt. Curtis O. Izzard
MSgt. Thomas P. Mabry
MSgt. Lee E. Swanson
MSgt. Michael W. Tedford

34 TTS
Maj. Kim A. Weber

53 MAS
Lt. Col. David E. Byrne
Lt. Col. Neil E. Hartschuh
Maj. James M. Kline
MSgt. Paul J. Mercadante
MSgt. Ronald D. Mantzey
MSgt. John W. Arsenault
MSgt. William C. Stevens
MSgt. Richard A. Satryb
MSgt. Elveret E. Manis
TSgt. Robin Hood
TSgt. Michael C. English
TSgt. Wilfred Jones
TSgt. James V. Franz

57 MAS
Capt. Robert M. Haley
SMSgt. Howard A. Schmidt
MSgt. Stephen B. Hodge
MSgt. Michael J. Polhemus
TSgt. Sanders J. Pratt

166 TAG
MSgt. William L. Wilmer

302 TAW/CV
Col. Jerry D. Boone

710 MAS
Lt. Col. Steven D. Bailey
SMSgt. Charles A. Carter

907 TAG
Col. Walter T. Hatcher, III.

14 MAS
Lt. Col. Kenneth B. Smith
MSgt. John A. Smith
TSgt. Stephen C. Coleman

16 TATS
TSgt. Patrick J. Hutton

17 TAS
SSgt. Christopher D. Jeffries

50 TAS
Lt. Col. Ronald B. Turney
Maj. Philip M. Omeeghan

52 MAS
Maj. Danny E. Durham
TSgt. John A. Reinhart

53 MAS
MSgt. William C. Stevens, Jr.

62 TAS
Maj. Robert L. Honaker
Maj. Edwin S. Richardson, III.
Maj. Wynn H. Wiegand

86 MAS
Lt. Col. Leslie J. Haaf, Jr.
TSgt. Jose R. Morales
TSgt. Michael L. Pierce
SSgt. Ronald L. Case

302 TAW
Lt. Col. Douglas A. Ohlde
SMSgt. Markle A. Bailey

349 MAW
Col. James L. Martin
Lt. Col. Dennis M. Lenihan
Lt. Col. Daniel J. Phillippi
Maj. William F. Brockett
Maj. George D. German
Maj. Thomas J. Hickman, Jr.
Maj. Gregory P. Lentz
Maj. Delbert D. Lewis, Jr.
Maj. John A. Macperson
Maj. Allan A. McCrary
Maj. Thomas S. Shoenberger
Maj. Dennis F. Silkebaken
Maj. Philip D. Webb
Maj. Edward M. Wilson
Maj. Glen D. Woolen
Capt. Stewart D. Irwin
SMSgt. Stephen E. Reynolds
MSgt. Lancer V. Bettencourt
MSgt. Maurice W. Harold
MSgt. Ronald D. Hatton
MSgt. Randy J. Leonard
MSgt. Angelo V. Lera
MSgt. Shawn R. Sanborn
MSgt. Nancy E. Turgeon
TSgt. Robert N. Jensen
TSgt. Roger A. Wilson

433 MAW
Maj. Dennis J. Timoskevich
1st. Lt. Udo K. McGregor

440 TAW
Maj. Roger L. Eberhardt
Maj. James F. Blackman
Maj. Robert F. Poland
Maj. Roger K. Profit
Maj. David A. Richards
Maj. Lowell E. Scott
Maj. Raymond E. Wallace
Capt. Michael C. Hadley
Capt. Wendell L. Nissing
MSgt. George C. Berthiaume

919 SOG
Maj. Robert F. Littlefield

928 TAG
Maj. Timothy A. Fuhrman
TSgt. Sun Wing T. Leung

934 TAG
Lt. Col. Arthur H. Howard
Maj. Richard P. Dwyer, III.
Maj. Charles W. Slack, III.
Maj. Gerald C. Vonberge
SMSgt. Franklin I. Hoffman
MSgt. Burl J. Hines
MSgt. Jimmie C. Munday
TSgt. James R. Keup

374 TAW
Lt. Col. John R. Mann
MSgt. Richard G. Brooks
MSgt. Edward H. Campbell
MSgt. Williard A. Sloan

438 MAW
Col. Kirby A. Woehst

443 MAW
SMSgt. Charles R. Padgett
MSgt. Stephen L. Blackwell
MSgt. George E. Liley

463 ALCS
Lt. Col. Jessie B. Usrey/CC
TSgt. James Fekete

616 MAG
Capt. William J. Schmid

772 TAS
Maj. Richard B. Keller
Capt. Richard J. Beitel
Capt. Roger L. Hollowell
SSgt. Raymond Guerrero

2,500

1 MAPS
SSgt. Duane Hutchinson

9 MAS
Lt. Col. Gregg R. Havens
Lt. Col. C. John Inglis
Capt. Raymond D. Lista, Jr.
TSgt. Neal R. Petty

16 TATS
TSgt. Richard D. Yates
TSgt. Felix A. Normand
SSgt. Marcel P. Lemieux

17 MAS
Capt. Michael R. Helms
SSgt. Michael A. Willard

41 MAS
Capt. Joseph T. Bender
Capt. Douglas F. Jamieson

54 WRS
SMSgt. Harold E. Newman
MSgt. Gary E. Peel
SSgt. Milton G. Kooyman, Jr.

57 MAS
Maj. William R. Park
Capt. Cary G. Davidson
Capt. Ronald U. Muse
Capt. Mondell R. Anderson
Capt. Thimothy W. Baldwin
Capt. Guillermo Berdini
Capt. David J. Britt
Capt. William F. Browning
Capt. David M. Burke
Capt. Michael V. Czarniak
Capt. Grover M. Trask
Capt. Thomas J. Ross
Capt. Gary B. D'Water
CMSgt. Wim H. Wetzel
TSgt. Robert B. Barber
TSgt. Paul S. Collins

62 TAS
Capt. Robert G. Connolly
Capt. Charles N. Kimsey
TSgt. William H. Yeary

166 TAG
Capt. Vincent P. Gambal
MSgt. William B. Pleasanton

302 TAW
Maj. Frederick W. Brown

349 MAW
Maj. Stephen N. Nyman
Capt. Michael B. Bonnette
Capt. Paul J. Dorais
Capt. Thomas G. Parker
Capt. Andrew C. Roberts
1st Lt. Gregory J. Daley
MSgt. Rodney Pascua
MSgt. Matti A. Raivio
MSgt. Enrique L. Ugalde
TSgt. Harold E. Palmer, Jr.
TSgt. Lloyd A. Smith
TSgt. Brenda L. Thompson
TSgt. James M. Vancuren

403 TAW
Col. John R. Cranton
Maj. Robert A. Cowell
Maj. Michael A. Davenport
Maj. Michael H. Joseph
Maj. Virgil W. Mather
Maj. Dennis L. Price
Capt. Jeffrey M. Dula
Capt. Roger L. Henry
Capt. William S. Maddox
Capt. Keith R. Milan
Capt. Mark C. Pistole
Capt. Charles F. Plash
1st Lt. Nola K. Cary
MSgt. Zack W. Lee
MSgt. Dalton R. Manning

443 MAW
Capt. Stephen O. McCallister
Capt. Jesse E. Hamby
MSgt. Robert P. McFadden
TSgt. John R. Shine
TSgt. Leonard J. Massotti
TSgt. Douglas E. Johnston

710 MAS
Capt. Mark J. Millican
SMSgt. Wayne A. Patton
TSgt. Forrest W. Cox
TSgt. George W. Korade, Jr.
SSgt. Richard M. Fahning

772 TAS
Lt. Col. Robert P. Mims
Lt. Col. Dan W. Hickox
Lt. Col. Danny J. Baird
Maj. Douglas J. Hearne
Capt. Kevin P. Mazurowski
Capt. James G. Wildner
MSgt. William A. Gilbreath
MSgt. Paul E. Klozinski
TSgt. William M. Martin
Sgt. Israel C. Hunter
Sgt. Daniel A. Smith

773 TAS
Lt. Col. William A. Bedford
Maj. Charles M. Anderson
Maj. Brian W. Bauries
Maj. Stephen D. Brown
Maj. Christopher M. Stuhldreher
Capt. Frederick R. Cianciolo
Capt. Ronald S. Herold
Capt. Randall G. Lucke
Capt. Joseph M. Potts
Capt. Rick Velasquez
CMSgt. Alan N. Bridgestock
TSgt. Christopher G. Ulibarri
TSgt. George W. Rogers
SSgt. Wayne L. Birchler
Sgt. Brian D. Wherle

919 SOG
Maj. Michael W. Hutto
Maj. Ronny C. Owen
Maj. James Shima
Maj. Thomas H. White, Jr.
Capt. Richard S. Haddad
Capt. Wesley W. Weathers
SMSgt. Almon L. Monday
MSgt. Stanley E. Long
MSgt. James L. Singletary
SSgt. Jeffery D. Elder

928 TAG
Maj. Lawrence M. Kampa
Capt. Daniel K. Gettinger
Capt. Gary W. Liverman
TSgt. Thomas F. King

943 TAG
Lt. Col. Leroy C. Gray
Lt. Col. Thomas W. Spencer
Maj. John L. Bauer
Maj. David C. Conradt
Maj. William M. Gormly
Maj. Robert A. Grant
Maj. Donald G. Griffin
Maj. John C. Kirry
Maj. George T. Phillips
Maj. Fred Rannalli, Jr.
Maj. Samuel L. Roach
Maj. Roger L. Wolfe
Capt. Michael A. Brousseau
Capt. Russell B. Brown
Capt. Robert A. Mauer
Capt. Michael J. Payne
Capt. Richard P. Rittenhouse
Capt. Jon C. Wooley
MSgt. David L. Brewer
MSgt. James R. Tavernese
TSgt. James E. Bault
TSgt. Terrence M. McMaster
TSgt. Lawrence E. Vik

1,000

AFELM
Capt. Edward B. Westerman

Ranks and units are those at time of award.

C-141

Structural Design Criteria and Severe Missions

By Mr. Taylor Wittel
Senior Structural Engineer,
Lockheed Georgia

The C-141 was the first aircraft in the military inventory designed from the outset to both civil and military structural design criteria. While it might appear this would involve numerous compromises, the fact is there are very few significant differences between military and civil structural design criteria for transport aircraft such as the C-141. As a result, no major problems were encountered in arriving at joint structural criteria that satisfied both requirements.

The first flight of the C-141A was on the 17th of December 1963, the 60th anniversary of the Wright Brothers' first powered flight. Powered flight thus spans a period of 85 years. The C-141 has been flying for 25 of those years, or almost one-third of the history of powered flight. Some might think this makes the C-141 an old aircraft, but we at Lockheed prefer to refer to it as a "mature weapon system."

Since 1963, the C-141 fleet has accrued more than 8 million flight hours. The average aircraft has more than 28,000 flight hours and some have more than 36,000. The significance of this is apparent when one considers the airplane was originally designed to a life of 30,000 flight hours with 1,500 hours of low level (1,500 feet AGL) operations and no contour flying.

To keep things in proper perspective, it is important to realize that the C-141 has been a very forgiving airplane, as shown by the fact that only 13 have been lost in 25 years. In only one case—an accident near Mildenhall, England, in 1976—was a structural failure in flight a contributing factor. This C-141 encountered turbulence which would have destroyed any transport aircraft in the world, hence the structural integrity of the aircraft was not a factor in the accident. Based on experience, it can therefore be concluded without fear of contradiction, that the C-141 is a safe and reliable aircraft when maintained and operated in accordance with established procedures.

STRUCTURAL DESIGN CRITERIA

Structural design criteria for the C-141 are detailed in an engineering report of several hundred pages. It is certainly not necessary, and perhaps not even desirable, for flight crews to be familiar with everything in that report. Information provided in Section V, "Operating Limitations," of the flight manual provides a concise, usable summary of the major items. However, a few points that have not previously

been made available, are important to emphasize when operating the aircraft near the edges of the flight envelope.

Pitch Axis

In the pitch axis, the airplane is designed for an abrupt elevator deflection followed by an abrupt check back to neutral, timed to reach but not exceed the design maneuver load factor. This is illustrated in Figure 1. Elevator deflections for both entry and check are maximum deflection rates available from the fully powered control system. Notice in the figure that maximum elevator deflection angle is significantly less than the 25 degrees trailing edge up deflection of which the system is capable. Since deflection shown is sufficient to yield 2.5g, it doesn't take much imagination to realize that 25-degrees elevator deflection would have resulted in a load factor significantly higher than 2.5g. In short, there is enough available elevator deflection to over-g and destroy the aircraft. This is one of two very good reasons why Section V of the flight manual prohibits abrupt maneuvers.

The other reason is, it is very easy to overshoot the 2.5g design load factor even with quite moderate elevator deflections if elevator return to neutral is not timed properly, or if the elevator is inadvertently returned past neutral. When these maneuvers are demonstrated during flight testing, several steps are taken to ensure safety:

- Control surface stops are used to ensure that planned elevator deflections are not exceeded.
- The airplane is thoroughly instrumented to measure the critical loadings.
- Real-time monitoring via telemetry is used so each point in a carefully controlled buildup can be evaluated by engineers before proceeding.
- Finally, the airplane is flown by a highly qualified test pilot who is quite accustomed to precisely performing these types of maneuvers and makes substantially more money than the average line pilot due to the risks he encounters.

The bottom line is that the elevator is designed for an abrupt check back to neutral, but not past neutral. The thing to remember, therefore, is never to return the elevator past neutral when recovering from a pitch maneuver.

Roll Axis

In the roll axis, the airplane is

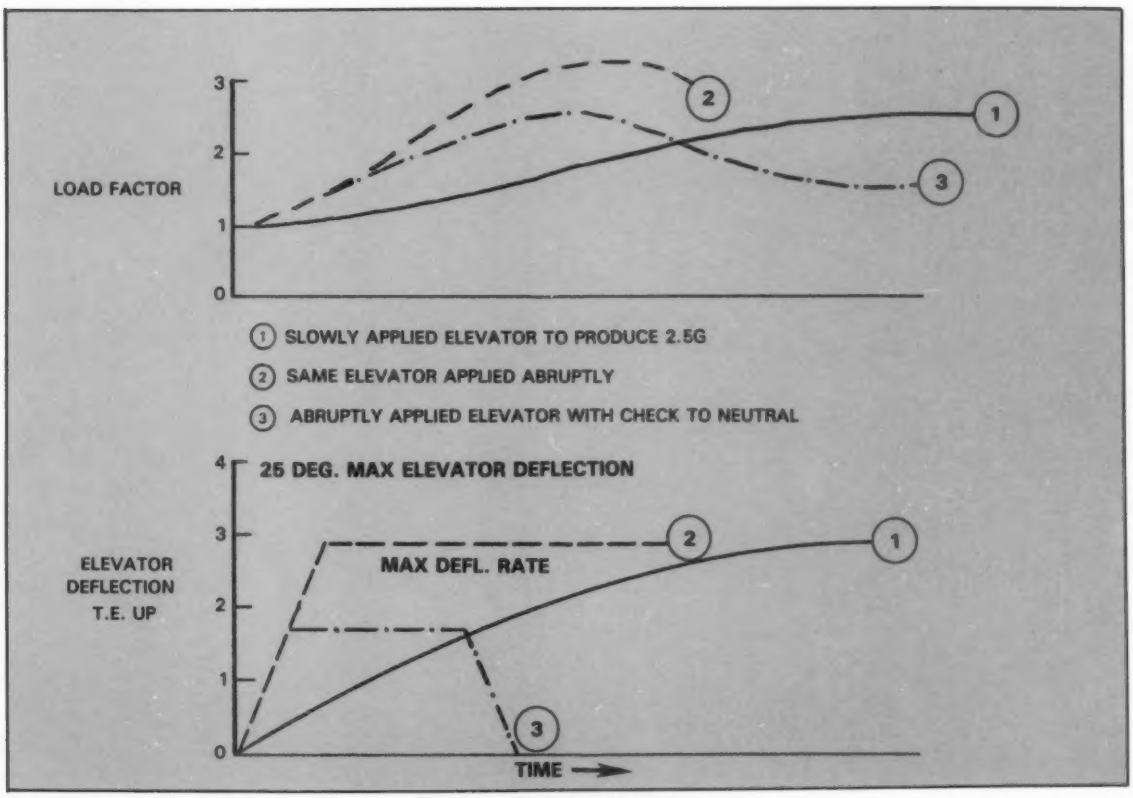


Figure 1. Pitch Axis Maneuvers

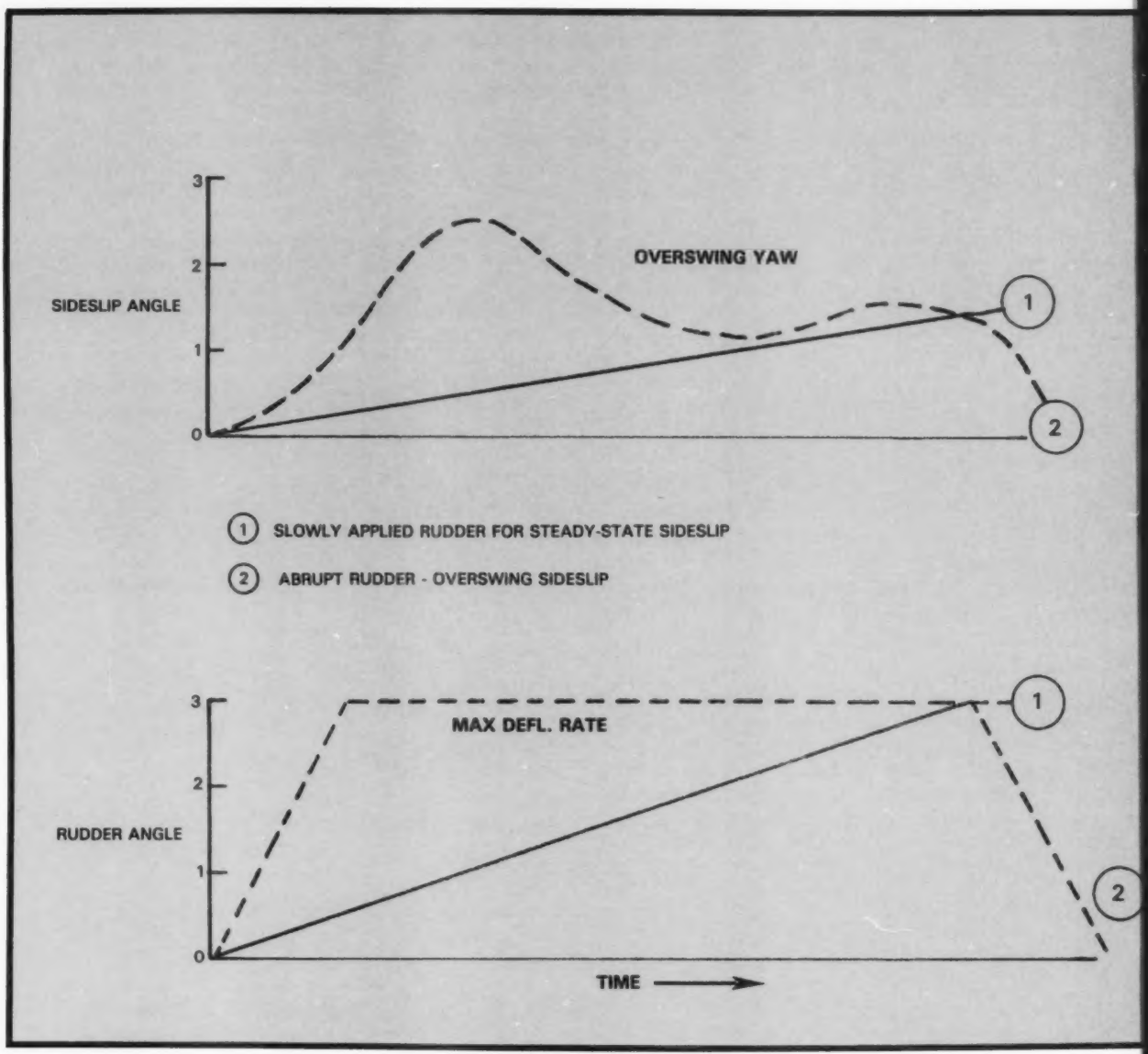


Figure 2. Yaw Axis Maneuvers

designed for ail the aileron a fully powered system is capable of delivering, followed by a full reverse check. As long as limitations of bank angle and load factor prescribed in Section V of the flight manual are adhered to, abrupt use of ailerons will not overload the structure. This does not mean that abrupt use of ailerons is recommended. It is not. Unnecessary abrupt use of controls in any axis causes fatigue damage that can shorten aircraft useful life.

Yaw Axis

The C-141, as well as all other transport aircraft, is designed for pilot-induced yawing maneuvers in 1.0g wings-level flight at speeds up to recommended speed V_H (maximum speed in level flight with maximum continous power). Full rudder deflection is input and held while the airplane is allowed to swing through maximum overswing yaw angle and back to steady-state sideslip. Then, and only then, is the rudder abruptly returned to neutral, but not past neutral deflection. This maneuver is illustrated in Figure 2.

The bottom line is that the airplane is designed for rudder maneuvers only in 1.0g wings-level flight; the rudder must never be returned past zero or neutral and the rudder must never be returned while the aircraft is in an overswing condition. As with elevator, enough rudder deflection is available to destroy the airplane.

Definition of Abrupt Deflection

Throughout this section, the term "abrupt" has been used to refer to control surface movements. The definition of an "abrupt control motion" is any motion that is faster than the airplane can follow. For normal operations, controls on any transport aircraft should never be moved faster than the aircraft can respond to that motion. Movement of the control faster than the natural response frequency of the aircraft does not increase the response rate of the airplane, it just overloads the structure and causes unnecessary fatigue damage.

Gust Criteria

There are two very important factors relative to gust, or turbulence, criteria. First, the aircraft is designed for turbulence encounter in l.0g level flight. In other words, the airplane is not designed for pilot-induced maneuvering on top of turbulence. Second, the C-141 is designed for exactly the same level of turbulence as any commercial transport such as the 747 or L-1011. There is protection for severe turbulence at speeds up to 270 knots, protection for moderate turbulence at speeds up to the recommended speed V_H, and protection for light turbulence in the yellow zone of the speed-altitude schedule up to the maximum speed V_D (maximum diving speed).

It is intuitive that if the airplane is designed for the above listed gust velocities in 1.0g flight, some pilot-induced maneuvering in turbulence can be tolerated in lesser gust environments; however, these are undefined. It is always desirable to avoid unnecessary maneuvering when penetrating turbulence. Trim the airplane for 1.0g level flight prior to penetration of turbulence and avoid maneuvering during actual penetration. Allow the aircraft to respond to turbulence and don't resist normal aircraft response unless a compelling reasons exist. The bottom line is that the C-141 is designed to essentially the same criteria as commercial airplanes and is not designed for intentional pilot-induced maneuvering combined with turbulence.

GROUND OPERATIONS

Ground operations include landing, taxi, jacking, towing, and various maintenance tasks. The aircrew is concerned primarily with the first two of these, so this section will not address the final three items.

Landing

Design rates of sink, gross weights, cargo, and fuel loadings, etc., are covered in Section V of the flight manual. One factor not addressed, however, is the airplane is designed on the basis of having 1.0g lift on the wing at the moment of touchdown during landing. This is why spoilers must not be deployed before the aircraft is firmly on the ground. If spoilers are deployed prior to touchdown, and the rate of sink is high, the wing will be overloaded in downbending and may even fail; therefore, the aircraft must be in a three-point attitude prior to spoiler deployment.

Taxi

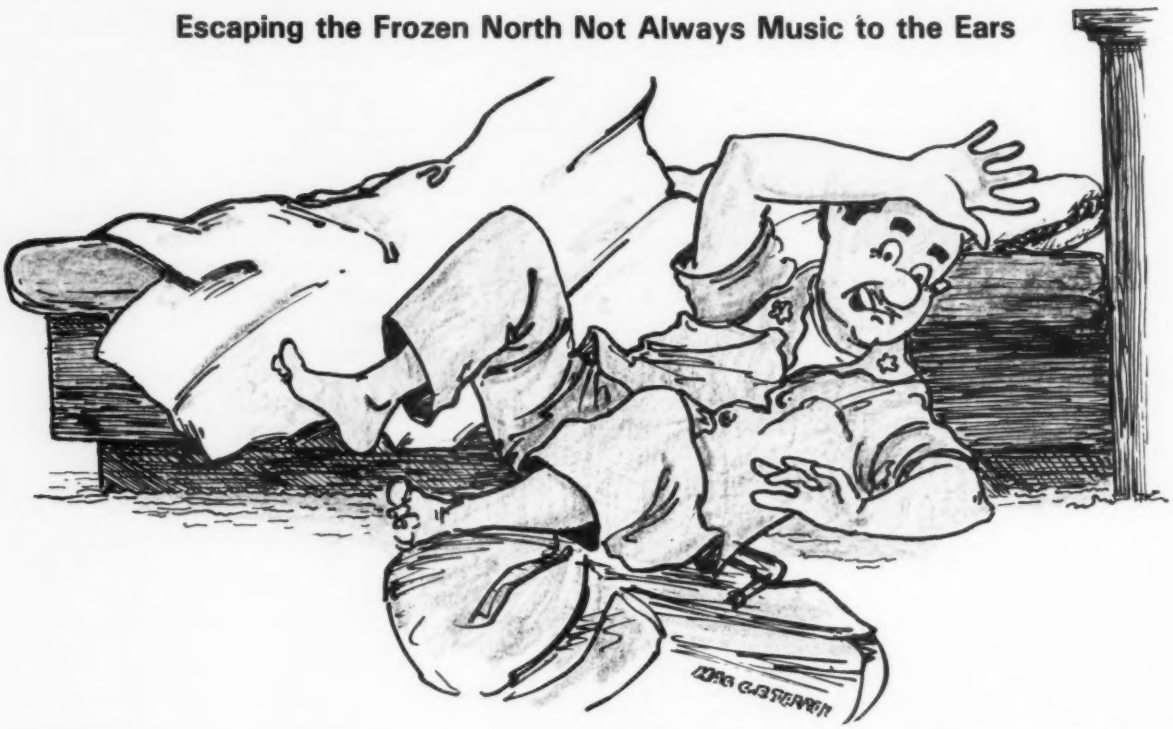
The C-141A was originally designed for a maximum ramp weight of 318,000 pounds. The landing gear and gear back-up structure were not beefed up for the C-141B configuration; therefore, the flight manual specifies certain limitations when operating at higher weights. These limitations must be observed or the structure may be overloaded.

An in-depth discussion of taxi criteria would be too involved for an article of this type; therefore, the following discussion is limited to those things that are directly controllable by the pilot.

The C-141 is designed for braked turns with symmetric braking. The aircraft is designed for unsymmetrical braking only during straight taxi on smooth runways. The airplane is designed to pivot about one main landing gear by locking brakes on that side and using asymmetric power to rotate the airplane about the locked brakes' side. The pivoting condition, however, does not involve forward velocity.

C.R. TERROR

Escaping the Frozen North Not Always Music to the Ears



(Editor's Comments: Due to popular demand (and approval from on high) that Able Aeronaut, that Pompous Pilot, that Master Manipulator of wires and tires, C. R. Terror, is back.)

. . . and a cheery good morning to all you listeners out there in radio land. This is Homely Platter-spin comin' to you from . . .

"Gadzooks! What is that infernal racket?" howled C. R. Terror, as he vaulted from his oversized waterbed, tripping over his overstuffed, hand-tooled, baby-blue B-4 bag. "It can't be O-dark-thirty already!"

By all accounts, C. R., the Lothario of the Airlift Game, had arrived at his date with destiny. Called back to active duty due to "the pilot shortage," the Bibulous Bumbler had narrowly escaped another brush with fate on his requal check—something to do with taking off without clearance—but that's another story. The requal complete, he was once again a Lockheed leader and C-130 aircraft commander. As luck would have it, the old crew was back together. Capt. L. S. "Long Suffering" Sam, copilot; Lt. Blinky Donivan, navigator; MSgt. Max Torque, flight engineer; and TSgt. Ty Downs, loadmaster, made up C. R.'s faithful but reluctant followers.

"Major Terror — sir," shouted Sammy, as the Field Grade Fumbler strutted through the squadron door in his freshly tailored flight suit. "I can't believe it's you!"

"Yes, Sammy m'boy, I'm a new man. A three month stint at Tassles Taylor's weight loss clinic and fruit-filled fat farm changed my life. I reached Nirvana, lost 35 pounds, and narrowly escaped being captured and held hostage by a band of underworked airline pilots, all in that short span of time."

"Well, boss, regardless of the methods, you look great. Blinky heard you were back and lined up a super return mission for us."

Even as he spoke, Sammy heard the obvious thud of a nav bag hit the floor behind him. As he turned, Sammy knew what to expect. Blinky, charts in hand, had just emerged from the flight planning room and caught sight of

the new, improved C. R.

"Boss," chirped Blinky, through clenched teeth from which protruded an ominous black grease pencil, "you're a mere shadow of your former self."

"Of course, m'lad. As I explained to Sammy, Colonel Fang has finally come to his senses and realized the error of his ways. He is once again making good use of the senior citizens of the airlift world—those over 30 years young. But now, I'm preachin' to the choir and cuttin' in on our valuable snack bar time. Let's be off."

With that, the Terrorific Threesome signed in, loaded pubs on the crew bus, and headed for base ops to check weather and NOTAMS, and file the flight plan (Max and Ty having long since left for the aircraft). The debut mission, should he choose to accept it, would take C. R. and his trusty crew to the sunny isles of the Caribbean. Our fearless crew had no idea what the cargo would be, but with a "one time good deal" that would get them out of the path of the latest Arctic Alberta Clipper, who or what rode aft of F. S. 245 was immaterial.

The good news of a sun-filled weekend in the Caribbean came crashing at C. R.'s feet when he reached the command post and found out what their cargo would be. It seems the U. S. Marine Corps band had some unscheduled time on their hands after the holidays. So, partly as a gesture of appreciation to the folks in the band, and partly in the name of good community relations, the powers to be decided to rent a Herk and do a two-stop tour of a couple of honeymoon havens in the South Atlantic. Just what C. R. needed on his first mission back—playing nursemaid to a bunch of flute-tooters. C. R. longed for the good 'ole days of hauling metal you didn't have to blow to get it to work. The news sent C. R. frantically searching flight suit pockets for his emergency supply of generic anti-acid tablets to quiet the burrito and chili breakfast (with extra onions) he had inhaled before leaving "Terror Manor" that morning. He was munching his third as he walked through the door of the weather room.

The stop-'n-shop visit with the weather folks proved interesting, with a forecast of isolated thunderstorms between the onload base of Crewcut Field and their first stop at Lovebird Isle. The weather guru also mentioned something about moderate turbulence in, and around, the thunderbumpers, which C. R. didn't hear as he headed out the weather shop door for the snack bar and his breakfast dessert of yogurt ice cream (part of the new diet, ya know).

The trip to the Herk was uneventful with the exception of C. R.'s unexpected detour to terra firma on the icy ramp. All was in order and an hour later our fearless crew was winging its way toward Crewcut Field. En route weather was good, and C. R.'s landing exceptionally smooth, much to the delight of the rest of the crew.

The orange glow of sunrise was beginning to show in the eastern sky as the Herk taxied to parking in front of base ops. C. R.'s blood ran cold as he caught sight of an ominously tall figure in full dress uniform. The flood-lit glare from the eagles on his shoulders temporarily froze C. R. and caused the marshaller to scramble for his life as Sammy jumped on the binders bringing the green machine to an abrupt halt.

Despite the morning chill, beads of sweat formed on C. R.'s brow as he neared the figure and offered his notoriously crooked salute. The awkward gesture was returned with the snap and precision of a finely tuned machine. C. R.'s eye caught what appeared to be an infantry rifle badge above the left pocket of the O-6's blouse which, upon closer scrutiny, turned out to be a band leader's baton. C. R.'s chuckle at the dichotomy was cut short by the booming basso profundo which split the morning air.

"What do you find so humorous, Major Terror?" The colonel's voice echoed off the surrounding buildings.

"Er . . . not a thing, Colonel . . . sir, just admiring the fine work of a good tailor. Do you have his card? I've got some party flight suits that could use a bit of cinching up and I thought . . . ."

"Cut the yap, mister. I was born in this uniform and couldn't be prouder of it. Now, get your people moving and get my band loaded. By the way Terror, if you so much as breathe on a tuba, let alone damage anything, I'll have your head. Colonel Fang and I were classmates back at ICU and he warned me about you. I also want a smooth ride since we'll be getting in some practice on the way. Now, get moving!"

"Yes sir. Not to worry, sir. You won't even know you're flyin'."

With that, C. R. and his band of trusty followers filled every nook and crany of the Herk's cargo compartment with tools of the musical trade. In no more time than it takes to whistle Dixie, the Rhinestone flyboy had rechecked weather and NOTAMS, filed his flight plan, and gotten the wheels in the well for the first stop—Lovebird Isle. C. R.'s spirits soared as he daydreamed of crystal blue waters and beaches littered with bikini-clad beauties. Even a baton-wielding Marine Colonel and a cargo compartment of noise-makers couldn't bring the once portly pilot back to his senses.

"Boss . . . boss . . . Major Terror, sir!" urged Sammy. C. R.

came back to reality just as the Herk, crew, and cargo coasted out. In the background, C. R. could hear the cacophony of what was obviously the band warming up for the en route rehearsal. C. R. had to seriously fight the urge to reach up and crank the cargo compartment air conditioning control to the full cold setting. Deciding at last that his loadmaster was under enough discomfort already, C. R. dismissed the idea.

"Yes, m'boy, what is of such urgency as to disturb me from deep meditation?"

"Well, sir, I was just wondering about that forecast we got for thunderstorms and turbulence. Don't you think we should get an update?"

"Nonsense, m'lad. The dispensers of weather wisdom were merely advising us that conditions exist for the formation of the monstrous menaces to powered flight. Besides, our trusty nav will keep us clear of the weather."

"Whatever you say, chief." With that, Sammy turned in his seat to catch that all-too-familiar look of resignation on Blinky's face.

The melodious banter from the cargo compartment had reached a fever pitch by the time Blinky brought C. R. back from his most recent bout with transcendental meditation.

"Pilot, navigator . . . AC, nav . . . hey, boss!" C. R. was again brought back to reality.

"I'm showing some pretty nasty weather on the radar scope. I think we should consider altering course quite a bit to the east."

"Balderdash, m' faithful plotter of LOPs. I'll not risk another encounter with the leader of the pack in the back, over a late arrival at Lovebird Isle."

At that very moment, the Herk departed all semblence of controlled flight. The cacophony in the rear came to an abrupt halt as tubas, trombones, and musicians went airborne.

C. R. instinctively disengaged the autopilot as the Herk broke out on the far side of the CB.

"Pilot, loadmaster, we've got some pretty irate folks back here but, aside from a huge dent in one of the tubas, everybody seems alright. By the way, the colonel is headed your way."

C. R. winced, and sunk in his seat, as the bellowing grew louder. The colonel's exact words would better fit the pages of a soldier of fortune magazine than those of *TMF*, but essentially, his admonition could be heard quite clearly by those picking up sheet music back around the paratroop doors.

"Pilot, engineer, I've got some more bad news for you. We've got some pretty bad hail damage on the wing leading edges. I think we better take her home."

With that, C. R.'s visions of emerald-blue waters and wall-to-wall bathing beauties disappeared as fast as parking spots at HQ MAC. The news of the return, as predicted, only served to fuel the fire under the Marine colonel.

Sammy had little trouble coordinating their return to home station (which just happened to be the closest place to put the hail-riddled Herk), and passing all the gory details to the command post.

Sammy, Blinky, Max, and Ty could only shake their heads as they witnessed the demoralizing incident. C. R.'s demeanor varied from that of a whipped puppy to stark fear as Colonel Fang and the Marine Corps colonel simultaneously read him the riot act on that cold winter afternoon. Despite the fact he had disregarded the weather forecaster's warnings, and exercised his usual lack of judgement, the Omnipotent One emerged from the episode surprisingly still wearing his wings. As he rejoined his crew in front of the battered flying machine, C. R.'s thoughts returned to his compatriots in the airline industry. Had he done the right thing by coming back? One look around the motley crew gave C. R. the answer. He was back where he belonged — *he was back to stay.*

Revolutionary Ideas Solicited

Now you folks all know I can't tell a lie. That cherry tree incident should have told you something. The fact is, the folks at *The MAC Flyer* could use your help. Day in and day out, the poor editors of *TMF* are beaten, whipped, and otherwise mentally coerced to produce the consistently high quality articles you see every month. Why, it's almost like being under the Red Coats again. Each of you can help ease the tyranny in Building 1522 by putting quill pen to parchment and sending in your most harrowing flight safety-related story. This effort will earn you a complimentary 1-year subscription to MAC's premier flight safety magazine. On top of that, contest winners will receive a beautifully inscribed desk set or wall plaque. The real payoff, however, comes from the fact that your story directly contributes to making the skies a safer place for all aviators — what could be more motivating? So come on, help out the slaves on the *MAC Flyer* staff and send that story in *NOW*. Your country and the staff will thank you. Just follow the rules below.

THE RULES

The 1990 MAC Flight Safety Writing Contest is conducted according to MACR 900-3 and these rules. Entries must be original, unpublished, contain an aviation safety/mishap prevention message, and be postmarked no later than 31 March 1990. Stories must be between approximately 1,000 and 3,000 words long (about 6 to 14 double-spaced typed pages). Poetry should average 75 to 100 lines. Manuscripts must be typed, double-spaced, and submitted in two copies. Identify entries by title only and attach a cover sheet indicating author's name, address, duty phone, unit and home address. Please include a brief biography.

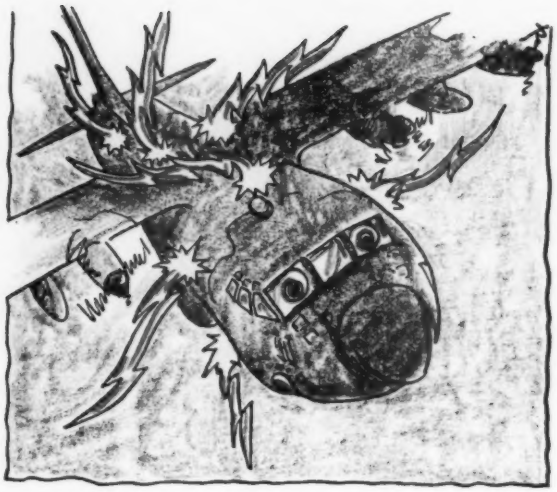
The contest is open to all. Entries qualifying under the above rules earn their author a complimentary one-year subscription to *TMF*. However, desk sets and plaques may be awarded only to military members and civilian employees of the Department of the Air Force and Air Reserve Components. Other entries may be selected for Honorable Mention, Special Category.

Winning entries will be published in *TMF*. Submit to:

MAC Flight Safety Writing Contest, 1990
HQ MAC/IGFE
Scott AFB, Illinois 62225-5101

QUICKSTOPPERS

HEATING UP THE AIRWAYS



Fighting the boredom of a navigation training flight, the aircraft commander attempted to phone home. After selecting the proper HF frequency, he keyed the mike and waited for the radio to tune. About ten seconds later, a student loadmaster and his instructor in the cargo compartment noticed a flickering light where none should have been. The instructor loadmaster discovered flames belching from the HF antenna tuner, grabbed a fire extinguisher, and doused the fire. The HF radios were isolated and the antenna feed wire removed from the tuner. Once safely on terra firma, investigators discovered worn gears inside the antenna tuning coupler had made the unit cycle continuously. The antenna wire, loosely attached, allowed arcing to occur. E.T., phone home.

GOOD 'OLE KEVLAR

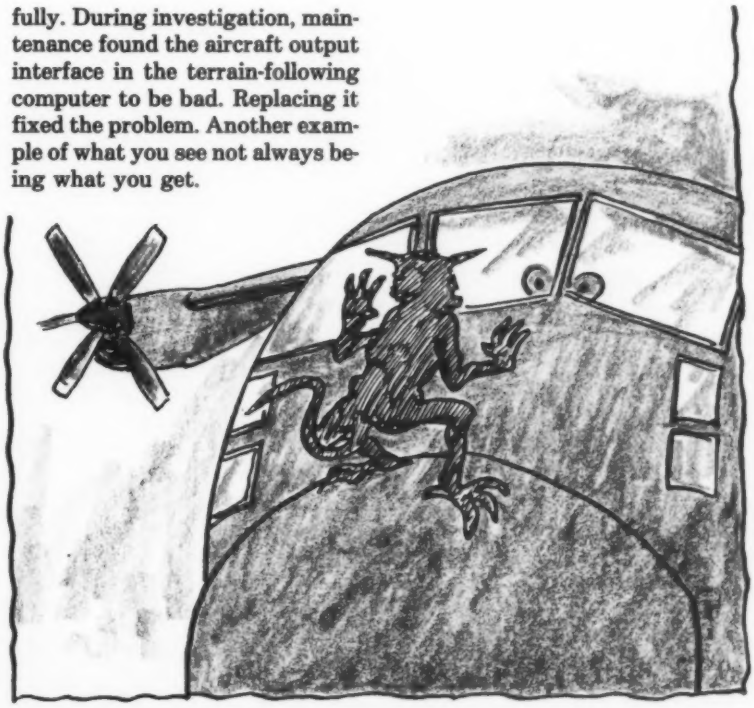
There is one lucky soldier walking around out there somewhere. A UH-60A got its right main landing gear stuck in the ground after landing at an LZ to drop off passengers. The aircraft tilted about 12 degrees to the right. One of the passengers left the aircraft before being released by the crew chief. When he stood upright near the edge of the rotor disk, the main rotor, which was only about six feet above the ground due to the tilt of the aircraft, struck his kevlar helmet a glancing blow. The soldier received a minor cut on the back of his head and was hospitalized for two days. The obvious messages here are for us to control our passengers, and for passengers to listen to crewmembers.

FOUR FOR FORE

This item, courtesy of the 436 MAW *"Flying Safety Highlights."* Matthew B'Yoa of Benin (small African country) drove a golf ball from a tee during a low-level flyby of the Benin Air Force's four planes. B'Yoa's shot crashed through the cockpit window of one plane which then crashed into the other three, destroying all four aircraft. Though the validity of the incident cannot be confirmed, it does give crews flying low level something else to worry about. Do you "chum" for golf courses? B'Yoa, by the way, was fined about fifty dollars.

COMPUTER GREMLINS

Recently, an MC-130 crew, on a night overwater terrain following mission, discovered gremlins in their radar system. The crew was operating in the 1,000-foot detent with the pitch signal select switch in ADI and the radar in cross-scan. They initially discovered a malfunction with the pitch bar during a climb. It appeared to be stuck over the top of the miniature airplane on the pilot's ADI. While climbing, it appeared to the pilot that he was following the pitchbar. Crosschecking, he discovered he was well above the water. He began a descent and continued to crosscheck. Once again, the pitchbar stayed over the top of the miniature airplane and it looked like the pilot was following the pitchbar. Recycling pitch signal select and ADI switches did not clear the problem. The crew flew a hard MSL altitude and returned to home station uneventfully. During investigation, maintenance found the aircraft output interface in the terrain-following computer to be bad. Replacing it fixed the problem. Another example of what you see not always being what you get.



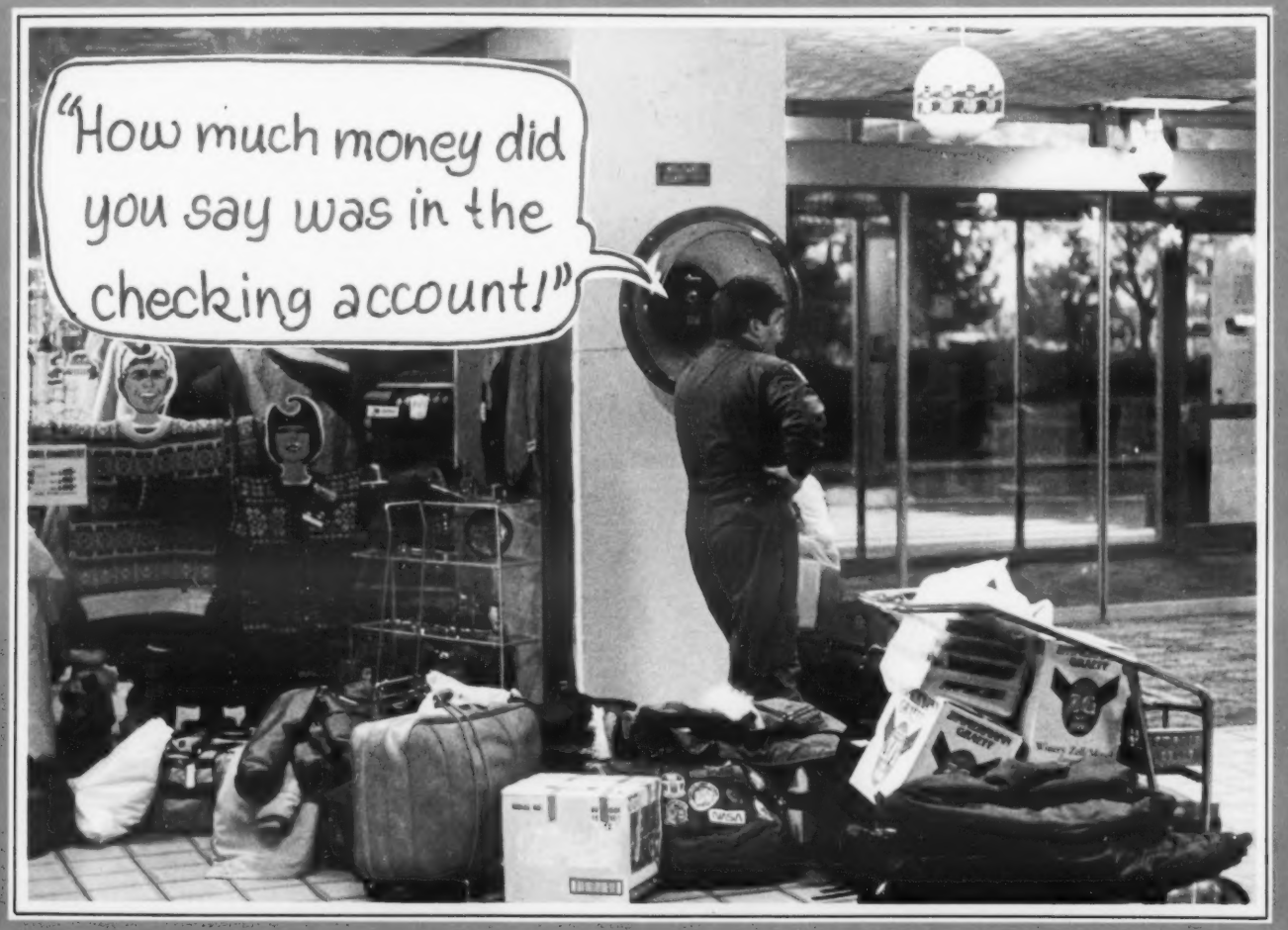
HALON ATTACK

The UH-60 was one of a flight of four taking part in a daytime tactical troop extraction exercise. The helicopter had picked up passengers and was flying at 300 feet AGL over hilly, heavily wooded terrain. As an added bonus, there were numerous high-tension power lines in the area. While the aircraft pressed along at 120 knots, the crew chief turned in his seat and reached to adjust intercom switches for one of the passengers on headset. As he did so, the crew chief unknowingly allowed his arm to rest on a Halon fire extinguisher mounted on the copilot's seat. Unfortunately, at some point prior to this, the extinguisher safety pin had broken and fallen out. When pressure was applied, the fire extinguisher performed as advertised, spraying the copilot (flying the aircraft) in the face, blinding him. Hearing the copilot's shout, the AC turned toward him and was hit in the left eye with extinguishing agent. Between two pilots, the crew was now down to one good eye and fumes affecting their breathing. The crew chief opened the gunner's window, clearing the cockpit just as one of the helicopter's sister ships called "wires" over the radio. The one-eyed AC, now flying the helicopter, executed a climbing turn and narrowly missed the rapidly approaching high-tension trap. Shortly thereafter, with the help of its sister ship, the stricken crew made a successful landing at a nearby airfield. Do you suppose the term "flying blind" got started this way?

After Deadlines

MAC PLAYS MAJOR ROLE IN "JUST CAUSE" - From 20 December , the first day of the operation, to 1 January, the first day of the redeployment of soldiers home, MAC continued to be a key player in the operation. The command airlifted more than 11,000 military members and 3,000 tons of cargo to Panama. MAC is also airlifting humanitarian aid to the country. On 1 January, MAC C-130s airlifted 56 soldiers to the United States, when the first contingent returned. MAC's 21st and 22d Air Forces provided tactical and strategic airlift on C-130, C-141, and C-5 aircraft, primarily for Army, Air Force, and Marine personnel; while 23d Air Force provided special operations support. MAC completed the initial employment phase of Operation "Just Cause" in 111 missions--84 airdrops--comprised of 22 C-130 missions; 77 C-141 missions; and 12 C-5 Galaxy missions. Follow-on security force airlifts included 13 C-5 and 40 C-141 missions. Twenty-four active duty MAC units participated in the operation. These involved not only C-130, C-141, and C-5 aircraft and crews, but aeromedical evacuation and special operations units, a weather detachment, maintenance crews, aerial port and airlift control squadrons. In addition, nine MAC-gained Air Force Reserve and nine Air National Guard units were involved in the operation.

OUR NOVEMBER ISSUE - Included a reprinted article from the Navy's *Approach* magazine entitled "Last Flight of the Memphis." Though the article was fictitious, the opening sidebar was based upon an actual Air Canada DC-9 mishap. The author mistakenly identified the source of the fire as a "passenger smoking." In reality, the NTSB report identified one of the probable causes of the mishap as "a fire of undetermined origin." Our apology for the oversight.

U.S. GOVERNMENT PRINTING OFFICE: 1990-754-014/20003

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